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Housing stress and mental health of migrant populations in urban China

Abstract

Social epidemiological studies have long understood housing as a social determinant of mental health. However, most studies have focused on the formal housing sector and the conceptualisation of housing is limited to the housing *per se*. This study aims to bridge the gap by investigating the mental health impact of housing disadvantages concerning the migrant population in China, who are largely excluded from the formal housing sector. Drawing from recent writings on stress as the intermediary agent between modern city life and mental illness, the study examines the relationship between housing and neighbourhood conditions, perceived stress and mental health status. Using a large-scale survey conducted in twelve Chinese cities in 2009, this research found that informal housing tenants have the highest level of perceived stress and worst mental health status compared to dormitory tenants and formal housing residents. Poor housing conditions are significantly associated with perceived stress but not with mental health, while the neighbourhood social environment significantly predicts both perceived stress and mental health. The paper concludes by calling for more ethnographic research on migrants' resilience and stress-coping strategies and more attention in urban planning and housing policy to address the vulnerability and adversity of migrant settlements.

Key words: Housing Stress; Mental Health; Migrants; Urban Life; China

Introduction

There are growing concerns, worldwide, about interdependencies between city life and mental wellbeing, with new evidence in the life sciences suggesting that the stress of modern city life could be a breeding ground for psychosis (Abbot, 2012; Kennedy and Adolphs, 2011; Lederbogen et al., 2011). City life is widely perceived as stressful, as "cities are polluted, unhealthy, tiring, overwhelming, confusing, alienating", and for disadvantaged groups, cities are "the places of low-wage work, insecurity, poor living conditions and dejected isolation" (Amin, 2006). This is particularly true for the mass of rural to urban migrants in China, who move to cities in search of better paid jobs and opportunities but find themselves situated in a highly precarious urban life with *hukou*-based social exclusions (Wu and Wang, 2014; Cheng et al., 2014; Liu et al., 2008; Zhang et al., 2014).

Indeed, contemporary urban China is experiencing growing social inequality that is largely characterised by migrants' marginalisation from social and economic opportunities in cities, including housing, employment, education, health and other services (Wu and Wang, 2014; Du et al., 2017). Social epidemiological studies revealed adverse mental health consequences of the economic, social and cultural aspects of exclusion experienced by rural migrants, such as lacking a formal working contract, lacking access to social insurance and experience of discrimination (Mou et al., 2011; Lin et al., 2011. For a comprehensive review, see Li and Rose, 2017). Nonetheless, few studies have paid attention to the mental health effects resulting from housing inequalities experienced by migrant populations, despite numerous studies highlighting migrants' poor living conditions stemming from their exclusion from the formal housing system and their (Huang and Tao, 2015; Logan et al., 2009; Wang et al., 2010; Liu et al., 2013). Several recent studies have investigated neighbourhood effects on migrants' mental health (Chen and Chen, 2015; Gu et al., 2015; Wen et al., 2010) but their research generally focused on formal residential neighbourhoods where only a very small proportion of migrants are housed, as the majority of migrant populations live in informal settlements (such as urban villages) and dormitories (Liu, et al., 2013).

In the international literature, housing, among various aspects of urban life, has long been recognised as a key social determinant of mental health (Sederer, 2016; Evans et al., 2003; Mari-Dell'Olmo et al., 2017; Shaw, 2004). These studies have revealed the adverse mental

health impacts of both physical aspects of housing, such as building design and housing quality, and the social and economic aspects, such as affordability, tenure and crowding (Evans et al., 2003; Bonnefoy, 2007; Cairney and Boyle, 2004; Gibson et al., 2011; Pierse et al., 2016). However, there are several gaps in the existing literature that require further research on housing and mental health in a developing context such as China. First, previous studies typically focused on housing conditions alone, without paying sufficient attention to the immediate neighbourhood context as an essential part of the residential environment. We contend that an expanded conceptualisation of housing should include both the dwelling and the neighbourhood to better understand the mental health impacts. Second, most studies on housing and mental health have been conducted in developed countries, and consequently, they focused largely on the formal housing sector. Yet, in the Global South, a large proportion of the urban population - particularly migrants - reside in informal settlements characterised by low housing quality, inadequate indoor and outdoor facilities, and a poor neighbourhood environment (Ren, 2017). Therefore, it is imperative to generate knowledge on the mental health effects of housing from the context of ongoing urbanisation in developing countries (Bonnefoy, 2007). Finally, many studies have reported only the associations between housing and mental health without further investigating the underlying mechanisms (Evans et al., 2003).

Drawing from recent writings about the role stress plays as a key intermediary experience linking urban life with its mental health consequences (Adli, 2011), this research aims to offer a more theoretically informed understanding of housing, stress and the mental health of migrant populations in rapidly urbanising China. It focuses not only on formal housing but also on informal housing and dormitories; not solely on housing *per se* but also on surrounding neighbourhood environments. It echoes the call of interdisciplinary research into the "neuropolis" (Fitzgerald et al., 2016) or "neurourbanism" (Adli et al., 2017) to "characterise urban stressors and their modulators" and thereby intends to inspire dialogues among researchers in urban studies, sociology and public health, with respect to the mechanisms between housing, stress and mental health .

Linking Housing, Stress and Mental health

The past few decades have seen increased scholarly interest in exploring stress response in the human urban environment. It was not until 2011, when Lederbogen's team identified

distinct neural mechanisms linking the urban environment to social stress, for the first time, that research shed light on the biological mechanism of city living that made the brain more susceptible to mental health conditions (Lederbogen et al., 2011; Abbot, 2012). Although housing – including its immediate neighbourhood context – is recognised as a critical aspect of city life, housing stress remains under-conceptualised and the aspects of housing that are linked to stress and poor mental health have not been fully understood.

In most narrow terms, housing stress refers only to financial strains, measured by housing affordability indicators (Rowley et al., 2015; Nepal et al., 2010). Studies reported that poor housing affordability affects mental health via the stress of housing payment difficulties (Bentley et al., 2011). However, social epidemiological studies have also found that overcrowding, residential instability, safety, and relationships with neighbours and landlords could cause stress and mental problems (Sandel and Wright, 2006; Quinn et al., 2010), and thus there has been a call for an expanded conceptualization of housing stress.

Following the World Health Organization's conceptual model (Bonnefoy, 2007), this research regards housing as a physical dwelling for residence that provides affordable shelter and basic living facilities, a protective refuge where one gets a sense of control and autonomy, and an immediate built environment where important daily activities occur in a safe environment. Unfavourable housing and neighbourhood conditions operate as chronic stressors that ultimately produce adverse mental health outcomes (Matheson et al., 2006; O'Campo et al., 2009; Polling et al., 2014). In a review of built environment and mental health, Evans (2003) summarised that better housing quality, including better building structures and indoor amenities (e.g., private bath, central heating), is positively associated with better mental health.

Other scholars stress the psychological benefits of home through providing a sense of privacy, security, control and identity (Dupuis and Thorns, 1998; Kearns et al., 2000). Saunders (1990) argues that "home is where people feel in control of their environment, free from surveillance, free to be themselves and at ease, in the deepest psychological sense, in a world that might at times be experienced as threatening and uncontrollable" (p361). Social medicine studies found that the meaning that people invest in their homes, their satisfaction with their homes and the amount of control they are able to exercise in the social and economic aspects of their domestic relations were empirically linked with self-reported

mental health status (Dunn and Hayes, 2000). A lack of privacy, sense of control and autonomy in one's home may generate pathological manifestations such as anxiety, depression, insomnia, paranoid feelings and social dysfunction (Bonnefoy, 2007).

In addition to housing conditions, unfavourable neighbourhood environments also operate as chronic stressors that ultimately produce adverse mental health outcomes (Matheson et al., 2006; O'Campo et al., 2009; Polling et al., 2014). Neighbourhood physical deprivation, such as deteriorating or poorly maintained buildings, poor state of street lighting and paved roads and limited access to resources and services has significant associations with levels of depression, as well as general mental wellbeing (Galea et al., 2005; Diez Roux and Mair, 2010; O'Campo et al., 2009). Neighbourhood social deprivation often signals a breakdown in community social control and leads to the perception of a residential environment as dangerous and threatening (Matheson et al., 2006; Galea et al., 2005). A pan-European study reported chronically severe annoyance instigated by neighbourhood noise could induce emotional stress and increase the risk of depression (Niemann et al., 2006). Perceived safety in the neighbourhood is also associated with stress and mental health (Booth et al., 2012; Diez Roux and Mair, 2010).

This paper, therefore, presents an empirical analysis of migrant populations in urban China to further investigate the mental health effects of various aspects of housing and neighbourhood stressors resulting from limited housing opportunities for migrants (refer to figure 1 for conceptual framework). Specifically, the empirical analysis is designed to investigates: (1) to what extent migrants living in formal housing may have lower levels of perceived stress and better mental health conditions compared to migrants living in informal settlements and dormitories, and (2) which aspects of housing stressors – e.g. cost burden, over-crowding, inadequacy of indoor facilities, and residential instability, and neighbourhood stressors; e.g. physical deprivation and social deprivation – are more significant predictors of perceived stress and mental health status of the migrant populations in China.

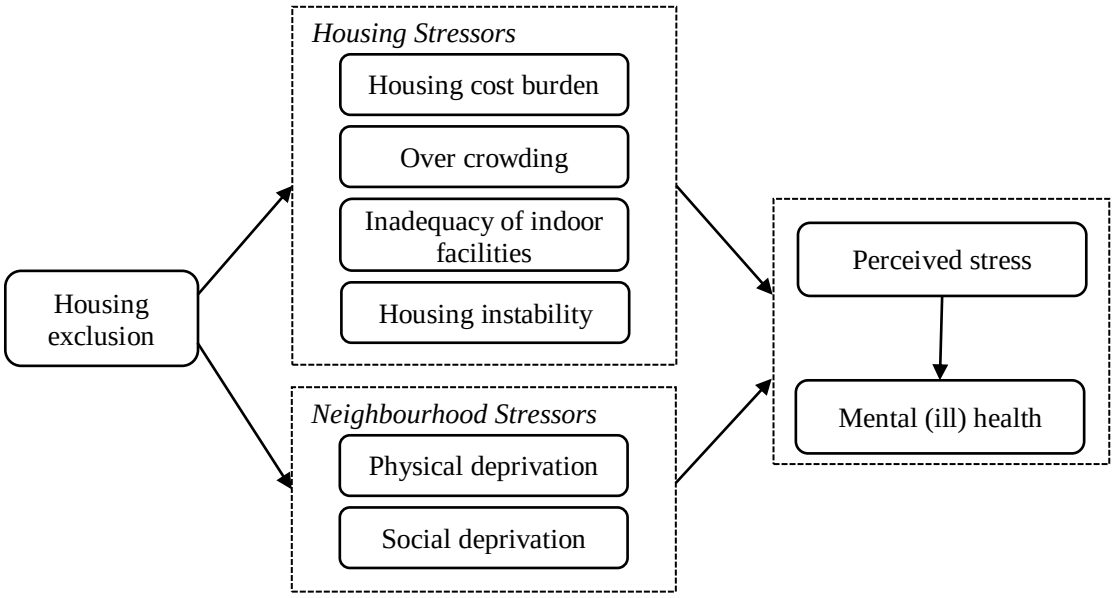

Figure 1. Conceptual Framework

Housing Migrants in Urban China

Numerous studies have unveiled the housing disadvantage of migrants in urban China resulting from the persistent institutional barriers of the *hukou* system, the dual land system and the discriminative affordable housing policy (Logan et al., 2009; Wu, 2004; Wu and Wang, 2014; Liu et al., 2013). Not only is homeownership generally out of reach for migrants, but even renting in the formal housing sector is difficult due to the lack of accessibility and/or affordability. Informal housing and employer-provided dormitories, thus, have been the most important sources of housing for migrants (Huang and Tao, 2015; Liu et al., 2013).

Informal housing refers mainly to housing in urban villages built by local villagers on collectively owned land, often out of formal urban planning and without municipal-government-supplied services (Wu et al., 2013). The physical environment in urban villages is generally characterised by high density, crowding, poor housing quality, and substandard and poorly maintained public facilities (Huang and Tao, 2015). Despite these unfavourable living conditions, studies generally have portrayed a positive social image of urban villages. They provide an important source of affordable housing for migrants, a place to earn a living and a territorial basis for migrants to pursue upward mobility and social integration. As such, migrants' own assessments of urban villages are not necessarily negative (Du and Li, 2010;

Li and Wu, 2013; Zhan, 2017; Liu et al., 2015). Nevertheless, Du et al. (2017) highlighted the emotional distance between rural migrants in urban villages and their urban milieu: migrants are still treated as outsiders and few can establish attachments and identities.

Dormitories provide another important source of low-cost housing for migrants, supplied by employers as an in-kind compensation to keep wages low and partly to facilitate long work hours. Such dormitories are mainly communal multi-storey buildings for factory workers, but also include other on-site or off-site living arrangements made by retail or service shop owners. Huang and Tao (2015) reported that migrants living in dorms experienced the worst living conditions: employer-provided housing "often lacks privacy, discourages the formation of families, and causes practical and psychological problems". In addition, employer-provided dormitories are socially embedded within a dormitory labour regime, "a highly paternalistic, coercive, and intensive production system"(Ngai and Smith, 2007), in which workers live in a highly regulated life and are deprived of autonomy and control over their private lives. On the positive side, however, migrants living in dormitories often enjoy shorter commutes, better neighbourhood environments and lower cost burdens, compared to those living in informal housing (Huang and Tao, 2015).

In short, although formal housing provides the best accommodation and neighbourhood quality, it is not accessible for the majority of migrants, incurs higher cost and increases financial stress. The concentration of migrants in either informal settlements or dormitories could indicate the prevalence of over-crowding, inadequate indoor facilities, and unfavourable neighbourhood environments, constituting additional sources of stress and mental health problems. Crowded residential environments may generate noise, unwanted social interaction, and disruption of sleep patterns or daily routines (Evans and Lepore, 1992; Evans et al., 2003; Conley, 2001). Inadequacy of indoor facilities may lead to residents competing for shared facilities. As a result, residents are in constant a state of alarme rather than at ease, because they have to increase their vigilance over the habits and schedules of others (Campagna, 2016; Hartig et al., 2003) and expose part of their private lives to others (Mubi Brighenti and Pavoni, 2017). Stress could also result from the higher possibility of daily hassles, such as arguments with neighbours, concerns about accidents, fears of confrontation, and/or from a compromised sense of privacy, autonomy and control at the residence.

Research Design and Methodology

Data source

The empirical analysis uses data from a 2009 twelve-city migrant survey that collected comprehensive information concerning various aspects of migrants' life experiences, as well as their health and subjective wellbeing. Respondents for the survey were limited to migrant populations who then worked and lived in the survey city, including migrants from other municipalities and migrants who were born in the survey city but had only rural *hukou*. The survey followed a multistage stratified sampling process. First, one large city, one medium-size city, and one small-size city were selected from each of the four major urbanised regions in China - the Yangtze River Delta, the Pearl River Delta, the Bo-Hai Bay Area, and the Chengdu-Chongqing Region. These regions are not only where most economic activities take place but also major destinations for rural-urban migration in China. Thus, twelve cities were selected to ensure representativeness of various types of destinations of rural-urban migrations. Five sub-districts (*jiedao*) were selected in each city, and in each sub-district, forty migrant workers were chosen to participate in the survey using a combination of random sampling (whenever possible), convenience sampling, and quota sampling (when a sampling frame was not accessible) to ensure as much representativeness as possible.

The survey was conducted via face-to-face structured interviews and yielded a total of 2,394 valid samples. The sample structure is fairly comparable to that from the 2010 National Population Census in terms of gender and type of migration (see Table 1). However, because of the nature of the interview survey, our sample included smaller percentages of underage and elderly migrants compared to the 2010 census. In this analysis, we included only a sub-sample of renters, including migrants currently living in dorms provided by employers, renting informal housing (typically in urban villages) and renting a formal unit. We explicitly excluded homeowners out of three concerns. First, owning a unit in the city is rare among migrant populations – 4.65% of our sample reported that they owned the unit in which they currently live. Second, the substantial differences between owners and renters, both in terms of their socio-demographic profile as well as housing and neighbourhood conditions, are likely to bias the estimated results from our model analysis. Third, some housing variables –

for instance, housing cost burden – are only available for renters. (Refer to Table 1 for the socio-demographic structure of the renter sample used in the analysis.)

Table 1 Socio-demographic structure of the sample

Variable Names		Renter Sample		Full Sample Percentage	National Statistics[#]
		Frequency	Percentage		
Gender	Female	918	43.88%	43.82%	46.69%
	Male	1,174	56.12%	56.18%	53.31%
Type of Migration	Intra-provincial	1,253	59.89%	59.19%	56.38%
	Inter-provincial	839	40.11%	40.81%	43.62%
Age Cohort	Under 19	144	6.89%	7.10%	19.84%
	20-29	874	41.79%	40.79%	32.79%
	30-39	607	29.03%	28.75%	22.10%
	40-49	364	17.41%	18.01%	15.21%
	50 and older	101	4.88%	5.35%	10.06%
Education	Middle school or less	1381	66.01%	65.46%	59.63%
	High school or more	711	33.99%	34.54%	40.37%
Hukou	Agricultural hukou	1,739	83.13%	81.58%	/
	Non-ag hukou	353	16.87%	18.42%	/
Marital Status	Not married	800	38.26%	37.57%	/
	Married	1,291	61.74%	21.43%	/
Occupation	Low skill	1,731	84.73%	84.26%	/
	Skilled	312	15.27%	15.74%	/
Age		Avg. 31.61 (9.95) [+]		31.88 (10.14)	/
Duration of residence in the city		Avg. 5.46 (4.89) [+]		5.56 (5.06)	/
Years of schooling		Avg. 8.87 (3.47) [+]		8.94 (3.49)	/
Per capita household income from non-agricultural work (1,000 yuan)		Avg. 43.03 (49.84) [+]		46.26 (77.30)	/

[a] Demographic structure of migrant population living in cities but with hukou registered outside the city from the 2010 National Population Census
[+] Mean value (standard deviation)

Variables and measurement

Measuring mental health and stress

There are two dependent variables. First, mental health was evaluated by the 6-item Kessler Psychological Distress Scale (K6), which is a rapid screening instrument for cases of mental illness. The respondents were asked during the past 30 days, how often did they feel a) nervous; b) hopeless; c) restless or fidgety; d) so depressed that nothing could cheer you up; e) that everything was an effort; and f) worthless. The response categories ranged 0-4, including “none of the time” (0), “a little of the time” (1), “some of the time” (2), “most of

the time" (3), and "all of the time" (4). The sum score from K6 ranges from 0 to 24, with a lower score indicating better mental health. The K6 scale has been validated in China and used in a number of mental health studies, such as in Lin et al. (2016) and Wen et al. (2016). Following previous studies (Prochaska et al., 2012; Kessler et al., 2010), we further recoded the mental health score into a three-scale ordinal variable, with the value of one referring to a K6 score under 5 (indicating good mental health), two referring to a K6 score of 5-12 (indicating moderate mental distress), and three referring to a K6 score higher than 12 (indicating several mental illness).

Second, perceived stress was measured by 4-item perceived stress scale (PSS-4). The PSS scale was developed by Cohen et al. (1983) to tap the degree to which respondents found their lives unpredictable, uncontrollable, and overloading. As an abbreviated version of PSS-14, PSS-4 asks respondents how often they felt or thought in a certain way during the past 30 days. Questions include the following: in the past 30 days, how often have you 1) felt that you were unable to control the important things in your life; 2) felt confident about your ability to handle your personal problems; 3) felt that things were going your way; and 4) felt difficulties were piling up so high that you could not overcome them. The sum score from PSS-4 ranges from 0 to 16 and a higher score indicates higher perceived stress.

Independent variables

We constructed two sets of independent variables to capture housing and neighbourhood characteristics that may result from limited housing opportunities for migrant populations, while controlling for social-demographic variables. Refer to Table 2 for descriptive statistics of key dependent and independent variables.

Housing characteristics included housing cost burden, overcrowding, inadequacy of indoor facilities, and housing stability. Housing cost burden was measured by whether the ratio of monthly housing costs (including rent and utilities) is more than 30% of monthly household income (coded as 1 if beyond 30%). Overcrowding was captured by both per capita living space in square metres (logged value) and sharing the room with non-family members (coded 1 if yes). To capture the availability of indoor facilities, we constructed a housing facility index as the average score of the availability of four utilities including tap water, a toilet, a bathroom, and a kitchen, with private access in the unit coded as 100, shared access in the building coded as 50, and no access coded as 0. Finally, housing stability was captured by

months of living in the current unit, categorized into a five-scale ordinal variable (less than 6 months, 6-12 months, 12-24 months, 24-48 months, and more than 48 months).

Neighbourhood characteristics were gauged through five variables capturing neighbourhood physical deprivation and social deprivation. Neighbourhood physical deprivation refers to underinvestment in neighbourhood services and public goods, which included two variables. First, inadequacy of neighbourhood facilities captures whether the respondent lives in a neighbourhood lacking facilities that comprise a good physical environment: paved road, street lights, and trash bins. Availability of neighbourhood services captures the types of amenities and services available within 1 kilometre from the neighbourhood, including shopping malls, grocery stores, movie theatres/gyms, schools, and hospitals. Neighbourhood social deprivation was measured by three variables that capture whether the respondents perceived their neighbourhoods as noisy, unsafe, and having crime incidents.

We included housing sources – employer-provided dormitories (reference categories), renting informal housing, and renting formal housing – to account for other possible mechanisms related to housing. We also controlled for type of migration, the length of residency in the city, and socio-demographic characteristics including age, gender, marital status, education (measured by years of formal schooling), income (measured by per capita household income from non-agricultural work), occupation (medium- to high-skilled jobs), and *hukou*. Refer to Table 1 for descriptive statistics of control variables.

Table 2 Descriptive statistics of dependent and independent variables

Variable Names		**Frequency**	**Percentage**
Sources of Housing	Dorms	853	40.73%
	Informal rental	1,011	48.33%
	Formal rental	229	10.95%
Length of living in current unit	<=6 month	555	27.41%
	6-12 months	350	17.28%
	12-24 months	417	20.59%
	24-48 months	412	20.35%
	>48 months	291	14.37%
housing cost burden (cost-income ratio >30%)		165	8.91%
Sharing room with non-family members		816	39.01%
Inadequacy of neighbourhood facilities		289	13.83%
Neighbourhood perceived noisy		378	18.09%
Neighbourhood perceived unsafe		548	26.21%

Neighbourhood perceived with crimes	519	24.95%
per capita living space (sq. meters)	Avg. 11.10 (13.12) [+]	
Housing facility index	Avg. 61.86 (31.87) [+]	
Types of services available within 1km	Avg. 2.82 (1.59) [+]	
Mental health scale (K6: 0-24)	Avg. 4.97 (3.57) [+]	
Perceived stress scale (PSS4: 0-16)	Avg. 7.06 (2.27) [+]	

[a] Per capita household income from non-agricultural work
[+] Mean value (standard deviation)
(Data source: 2009 twelve-city migrant survey)

Empirical Findings

Model of perceived stress

We first ran multiple linear regression models to investigate the extent to which housing and neighbourhood conditions predict the perceived stress level of migrant populations in Chinese cities. (Refer to Table 3 for model results, where model 1 included only housing and neighbourhood characteristics and model 2 further controlled for sociodemographic characteristics.)

Table 3. Regression of perceived stress scale on housing and neighbourhood conditions

	Model 1 (DV: PSS-4)		**Model 2 (DV: PSS-4)**	
	Coef.	**Std. Err.**	**Coef.**	**Std. Err.**
Sources of housing (ref: dorm)				
Rent informal housing	0.378	0.159 **	0.444	0.164 ***
Rent formal housing	0.120	0.216	0.422	0.223 *
Housing cost burden >30%	0.378	0.198 *	0.207	0.210
Per capita living space (sq.m)	-0.183	0.077 **	-0.145	0.079 *
Sharing room with non-family members	0.116	0.157	-0.170	0.176
Housing facility index (0-100)	-0.003	0.002	-0.005	0.002 **
Length in current unit (ref: <=6 months)				
6-12 months	-0.046	0.174	0.049	0.173
12-24 months	-0.155	0.162	-0.078	0.164
24-48 months	-0.309	0.163 *	-0.179	0.169
>48 months	0.084	0.185	0.402	0.203 **
Inadequacy of neighbourhood facilities	-0.248	0.168	-0.139	0.171
Types of services within 1km	0.038	0.036	0.020	0.036
Neighbourhood perceived noisy	0.356	0.147**	0.366	0.147 **
Neighbourhood perceived unsafe	0.350	0.153**	0.317	0.154 ***
Neighbourhood perceived with crime	0.109	0157	0.022	0.158
Years of residence in city			-0.020	0.014
Interprovincial migration			-0.044	0.128

Age		-0.008	0.008
Gender (male=1)		-0.154	0.116
Marital status (married=1)		-0.628	0.166 ***
Years of schooling		0.002	0.021
Income from non-ag work (logged)		-0.240	0.088 **
Occupation (skilled=1)		-0.348	0.173 **
Non-agricultural *hukou*		-0.038	0.164
REGION (Ref: Yangtze River Delta)			
Bo-Hai Rim		-0.594	0.188 ***
Pearl River Delta		0.426	0.190 **
Chengdu-Chongqing		-0.001	0.189
R^2(Adjusted R^2)	0.0418 (0.0360)	0.0716 (0.0554)	
N	1974	1574	

Note: * p<0.1; ** p<0.05; *** p<0.01
(Data source: 2009 twelve-city migrant survey**)**

The results show that renting informal housing significantly predicts a higher stress level for migrant populations compared to living in employer-provided dorms, even when housing and neighbourhood characteristics are accounted for. All else held constant: the average perceived stress level for migrants renting informal housing is 0.444 higher than that of migrants living in dorm (see model 2 in Table 3). Surprisingly, renting formal housing does not contribute to a lower level of perceived stress. Rather, with the control variable included (model 2), renting formal housing is weakly associated with higher perceived stress.

Migrants who face a higher housing cost burden tend to have higher perceived stress but the coefficient is only weakly significant in model 1 (coefficient=0.378, p<0.1; Table 3) and becomes insignificant in model 2 when control variables are included. As expected, better housing conditions – e.g., larger living space and better in-house facilities – predict a lower perceived stress level. As model 2 results show, both per capita living space and housing facility index are negatively associated with the perceived stress scale, though the coefficient for living space is only weakly significant (p<0.1) in model 2. Additionally, a longer duration of living in the current housing unit does not have a consistent effect on perceived stress. Nevertheless, living in the current unit for more than two years does prove significant at 0.05 level in predicting higher perceived stress. This is possibly because of the cumulative effect of housing stress exposure over two years.

With respect to the neighbourhood environment, migrants do not necessarily have a higher level of perceived stress when living in a materially deprived neighbourhood – neither

inadequacy of neighbourhood facilities nor *types of available services* is significant in either model 1 or model 2. However, migrants do have a higher level of perceived stress if they perceive their neighbourhoods as noisy or unsafe (coefficients = -.366 and 0.317, respectively; see model 2 in Table 3). The results indicate that neighbourhood social deprivation plays a significant role in stress perception.

Among the control variables, age, gender and education are not significantly associated with perceived stress levels. Unmarried migrants do tend to have a lower level of perceived stress; all else held constant. The average score of perceived stress scale for unmarried migrants is 0.628 lower than that of married migrants ($p<0.01$; see Table 5). Meanwhile, higher income and better occupation are associated with a lower level of perceived stress, both significantly at the 0.05 level (coefficient==-0.240 and -0.380, respectively), indicating a positive mental health effect of better economic accomplishments and integration of rural migrants in Chinese cities. However, a longer duration of living in the host city has no significant correlation with perceived stress levels, which seems to contrast with our expectation that a longer process of assimilation would help reduce the stress levels of migrant populations.

Model of mental health scale

We ran an ordinal logistic regression of mental wellbeing (K6). We first ran the model with only the perceived stress scale, as well as housing and neighbourhood characteristics (model 3), and further included sociodemographic variables (model 4; see Table 4 for model results). Not surprisingly, the perceived stress score is a strong and consistent predictor of the mental health score; all else equal, a higher perceived stress score is associated with a higher score of mental health scale on a 0.01 significance level (coefficient = 0.161 in model 4, see Table 4). When housing and neighbourhood characteristics are accounted for, the housing source *per se* is no longer a significant predictor of mental health status. Specifically, renting formal housing does not necessarily predict better mental health than living in dorms, whereas renting informal housing is weakly associated with a higher score on the mental health scale (i.e. lower mental wellbeings) compared to living in dorms (coefficient=0.323, $p<0.1$; see model 3) but not significant in the full model (see model 4 in Table 4).

Table 4. Ordinal regression of mental health scale on housing and neighbourhood conditions

	Model 3 (DV: K6)	Model 4 (DV: K6)

	Coef.	Std. Err.	Coef.	Std. Err.
Perceived stress (PSS-4)	0.151	0.023 ***	0.161	0.024 ***
Sources of housing (ref: dorm)				
Rent informal housing	0.278	0.144 *	0.178	0.195
Rent formal housing	0.108	0.197	0.035	0.074
Housing cost burden >30%	0.291	0.180	0.165	0.165
Per capita living space (sq.m)	-0.013	0.070	0.001	0.002
Sharing room with non-family members	-0.083	0.143	-0.204	0.163
Housing facility index (0-100)	-0.003	0.002 *	-0.002	0.002
Length in current unit (ref: <=6 months)				
6-12 months	-0.022	0.156	-0.040	0.161
12-24 months	-0.084	0.145	-0.090	0.152
24-48 months	-0.246	0.148 *	-0.239	0.158
>48 months	-0.305	0.167 *	-0.352	0.191 *
Inadequacy of neighbourhood facilities	-0.036	0.154	-0.073	0.161
Types of services within 1km	0.046	0.032	0.047	0.033
Neighbourhood perceived noisy	0.296	0.133 **	0.336	0.136 **
Neighbourhood perceived unsafe	0.028	0.139	0.042	0.143
Neighbourhood perceived with crime	0.310	0.141 **	0.397	0.146 ***
Years of residence in city			0.015	0.013
Interprovincial migration			0.068	0.119
Age			-0.002	0.008
Gender (male=1)			-0.231	0.108 **
Marital status (married=1)			-0.247	0.157
Years of schooling			0.041	0.020 **
Income from non-ag work (logged)			-0.073	0.083
Occupation (skilled=1)			-0.174	0.165
Non-agricultural hukou			0.318	0.153 **
REGION (Ref: Yangtze River Delta)				
Bo-Hai Rim			0.231	0.176
Pearl River Delta			0.061	0.179
Chengdu-Chongqing			0.214	0.177
Log likelihood	-1269.1359		-12315.1972	
Pseudo R^2 (R^2)	0.0268		0.0481	
N	1617		1572	

Note: * p<0.1; ** p<0.05; *** p<0.01
(Data source: 2009 twelve-city migrant survey**)**

It is interesting to find that housing characteristics do not have the same strong predicting power for mental health as they do for perceived stress. While a few variables capturing housing opportunities and conditions are weakly significant at the 0.1 level in model 3, they become insignificant in predicting a mental health scale in the full model where socio-demographic controls are included (model 4). Better housing quality – measured by the housing facility index – is also associated with a lower mental health scale score on a 0.1

significant level (coefficient=-0.003; see model 3 in Table 4). None of these variables remains significant when controlling for socio-demographic characteristics (model 4). To our surprise, crowding has no significant relationship with mental health in both models, which contradicts previous research findings in Western countries (Evans et al., 2003).

Among neighbourhood characteristics, similar to results from the perceived stress models, the perceived availability of neighbourhood facilities and amenities does not significantly predict migrant populations' mental wellbeing. However, migrants do tend to report lower mental wellbeing if they live in a neighbourhood that is noisy or harbours crimes. All else equal, the average score on the mental health scale is 0.388 higher if a migrant resident perceives the neighbourhood as noisy than if not, and 0.391 higher if a migrant resident has heard of any crime incident in the neighbourhood over the past six months than if not. Both coefficients are significant at the 0.01 level (model 4 in Table 4).

With respect to sociodemographic variables, it is interesting to find that neither income nor occupation is significantly associated with mental wellbeing, despite their associations with lower perceived stress (Table 4). Instead, education matters more in mental wellbeing. To be more specific, higher education is associated with a higher average score on the mental health scale (worse mental health) for migrant populations (coefficient=0.041, $p<0.05$), which is consistent with some of the previous studies (Mou et al., 2011). Finally, the results also show that male and married migrants tend to have lower scores on the mental health scale – i.e., better mental wellbeing – than female, unmarried migrants, although years of residence in the host city, inter-provincial migration, age, and *hukou* are not significant.

Discussion and Conclusion

In this study, we sought to advance the literature on housing and mental health by drawing upon the recent urban stress thinking and investigating the mental health implications of housing disadvantages for migrant populations in urban China. We developed a conceptual framework of housing stress that regards housing not only as a physical dwelling with basic facilities, but also offering a sense of control and stability, as well as ease with the immediate neighbourhood environment. Our research contributed not only to the existing literature on city life and mental health, which has been mostly focused on the developed countries, but

also has implications for other countries in the Global South, where informal settlements with inadequate housing conditions are prevalent.

Studies in developed countries typically found a significant mental health impacts from poor housing quality and overcrowding (Baker et al., 2016; Evans et al., 2003). However, our study of China's migrant populations found them to be insignificant to mental health status, though significantly predicting higher stress. This is possibly because what is perceived as "poor housing quality" and "overcrowding" can differ between different individuals and in different cultures: thus, the objective measurement of housing quality may have different subjective meanings. Most migrants in Chinese cities tend to view their urban dwellings as temporary, as they plan to eventually return to their hometowns. Thus, their subjective wellbeing may be less synonymous with their current unfavourable housing conditions. Studies on informal settlements and mental health have emerged in recent years, focusing primarily on basic infrastructure such as sanitation, electricity, and water (Corburn and Karanja, 2016; Snyder et al., 2014). These infrastructures are largely available in China's urban villages. Our research found that perhaps the most health-related factors for China's migrant populations are neighbourhood social deprivation, such as lack of safety, social disorder, and precariousness, as urban villages are under constant threat of demolition.

There are several policy implications from this research. First, our findings indicated that neighbourhood social deprivation creates potential stressors detrimental to mental health, but neighbourhood material deprivation is less relevant. In particular, neighbourhood noise and perceived safety are significantly associated with both perceived stress and mental illness, which is consistent with other studies (Chen and Chen, 2015). Therefore, planners and policy makers should pay more attention to the neighbourhood social environment, in addition to physical infrastructure provision, and focus on cultivating socially cohesive communities. Second, contrary to the popular notions that dormitories are crowded and regulated places with little autonomy or control for migrant workers (Ngai and Smith, 2007), our analysis found that dormitory tenants have the least perceived stress and best mental wellbeing compared to migrants living in both informal and formal housing, even when housing and neighbourhood characteristics are accounted for. This finding highlights the importance of employer-provided dormitories as one key housing option for migrants, which would reduce their housing cost burden and offer a place where new social ties and a sense of belonging can be developed. Therefore, to address the housing needs for migrants, governments may

consider incentives for employers to provide better and decent housing for migrant workers. Finally, informal housing dwellers tend to possess higher perceived stress and worse mental health status, despite that previous studies reporting strong neighbourhood sentiment and social ties in urban villages in China. Our research thus suggests the necessity to re-examine both physical and social environments in urban villages from a public health perspective.

One limitation of this study is the lack of more detailed data (both quantitative and qualitative) regarding the specific mechanisms whereby housing stress is generated and negotiated, necessitating further research in the future. For instance, the association between inadequate living space and indoor facilities and higher perceived stress could be due to the compromise in ontological security or due to the increase in daily harassment. However, empirical data regarding the meaning of home or the everyday experience at a residence is absent. Furthermore, while life sciences have suggested that stress is the intermediary agent between urban life and mental illness, this research found that aspects of urban life (such as crowding and inadequate facilities in housing) associated with stress do not necessarily lead to mental illness. This may relate to the resilience and the management of subjectivity in dealing with stress demonstrated by people of lower social status in a way that they may align their expectations with their limited resources to avoid a harmful cognitive dissonance (Hu and Coulter, 2017) or adapt to their unfavourable living environment by developing set of rules and behaviour strategies to support themselves (Ellisa, 2016). More ethnographic data is therefore needed to examine migrants' subjective experience and stress-coping strategies in less desirable housing conditions, as well as the meaning of migration and the meaning of home to migrants, to understand the more specific mechanisms of housing, stress and mental health.

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